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File: USPT

Dec 18, 2001

DOCUMENT-IDENTIFIER: US 6331850 B1
TITLE: Collapsible keyboard

US PATENT NO. (1):
6331850

Abstract Text (1):

A collapsible keyboard assembly having, in one embodiment, a plurality of keys each of the plurality of keys having a top portion and a portion of the plurality of keys displaced adjacent one another to form at least one row. A plurality of keys are coupled to a support element which is capable of being extended to a first footprint and is capable of being contracted to a second footprint. Each of the keys includes a key top which is coupled to a key base. Each key top is designed to be pressed by a user. For each key, the key top and key base rotate on a pivot point which couples the key base to the support element. Each key base rotates as the support element is extended and contracted. One embodiment also includes a plurality of scissors linkages, each linkage having a pair of diagonally opposed leg portions coupled to one another, with a portion of the plurality of scissors linkages pivotally coupled to at least one of the keys of the row. The plurality of scissors linkages are adapted to have a first position such that the top portion of each of the keys of the row defines a substantially horizontal plane and a second position such that the top portion of each of the keys of the row traverses the substantially horizontal plane. Features of various aspects of certain embodiments of the invention include coupling adjacent scissors linkages to form rows, coupling protective side portions to the ends of the keyboard assembly to encapsulate the key mechanism of the assembly when the keyboard is in a collapsed position, and using the mechanical structure of the keyboard as a conductor so that each row of keys bridges a two-wire bus that may be sequentially scanned by a controller to determine which keys are pressed. Another feature of an embodiment of the invention uses a flexible conductor.

Brief Summary Text (9):

Other designs of keyboards include those where the keyboard is hinged at the center of its length and folds about a vertical axis. U.S. Pat. No. 5,457,453 describes a keyboard that folds to greater than half its length. U.S. Pat. No. 5,574,481 describes a keyboard that folds in half and appears to have a non-standard layout of keys (the keys on the center fold axis have edges which lie in a straight line). U.S. Pat. No. 5,653,543 describes a keyboard that folds in half. U.S. Pat. No. 5,502,460 describes a keyboard with two vertical hinges that folds to greater than half its unfolded length.

Brief Summary Text (13):

The present invention provides, in one example of the invention, a collapsible keyboard which includes a support element and a plurality of keys. The support element can be extended to provide a structure having a first footprint and contracted to a structure having a second footprint, where the second footprint takes less surface area than the first footprint. The plurality of keys are coupled to the support element. Each of these keys includes a key top, which is designed to be pressed by a user, and a key base which is coupled to the key top. The key top and the key base rotate, in one example of the invention, on a pivot point which couples the key base to the support element when the support element is extended and contracted.

Brief Summary Text (17):

In one embodiment of the invention, the keys of the keyboard assembly are coupled to and supported by a support element which is a series of rows of multiple scissors-like, diagonally or X-shaped hinged linkages connected to the assembly housing. The linkages are selectively shaped such that any keyboard layout may be adopted, including the standard "QWERTY" layout with its staggered columns and various width keys. The linkages also provide a wide ratio of contraction, yet due to their diagonal shape when expanded, provide a strong and rigid structure. The hinged linkages create very little friction and do not require lubrication, so the keyboard assembly can be repeatedly opened and closed smoothly and easily. The keys are pivotally attached to the linkages, and by means of swing arms, pivot from a near vertical position, when the keyboard assembly is collapsed, to a horizontal position, when the keyboard assembly is expanded. To provide for a more compact profile when the assembly is collapsed, the keys are compressed to a closed and nesting position. In one exemplary embodiment, the pivotal attachment point for key bases of one set of keys differs from the pivotal attachment point for key bases of another set of keys.

Detailed Description Text (6):

As shown in FIG. 3, the row of scissors linkages 4 includes a plurality of scissors linkages which are connected in series. Three such scissors linkages 4a, 4b, and 4c are shown in FIG. 3 and are connected from left to right respectively. Each scissors linkage includes two legs which are coupled together at a pivot point by a pin or rivet. Each scissors linkage is coupled to the next scissors linkage in the row by a pivot point on one leg and a pivot point on another leg. Further details regarding the scissors linkages of one embodiment of the invention are described below.

Detailed Description Text (8):

The keyboard assembly stops expanding, in one embodiment, when the two end legs on each side of a row of scissors linkages are restricted from closing down upon each other. This can be seen from FIG. 3 which shows that a row of scissors linkages 4 is coupled on each side of the row to a pivot point within the respective housing. Specifically, the housing 2 on the right side of the keyboard assembly is coupled to the row of scissors linkage at pivot points 24 and 23. This pivot point 23 includes an opening in a leg of the last scissors linkage on the right side of the row, and a pin or rivet which extends through the opening and which is attached to the inner wall of the housing 2. Pivot point 24 includes an opening in the other leg of the last scissors linkage on the right side of the row and a pin or rivet which extends through the opening and which pin or rivet also rides in a channel 25 formed in the inner wall of the housing 2. The channel 25 allows the pin at pivot point 24 to ride up and down the channel as the keyboard assembly is collapsed and extended respectively. Note from FIG. 4 how the pivot point 24 has moved to half-way along the channel 25 when the keyboard is semi-collapsed. The bottom end of the channel 25 defines the stopping point for the extension of the keyboard assembly. A similar arrangement exists at the last scissors linkage on the left side of this row of scissors linkages as shown in FIGS. 3, 4 and 5. A keyboard on/off switch at the end of the channel 25 may be activated by a pivot point 24 when that pivot point reaches the end of the channel at the end of the keyboard's expansion. In this way, the end of the keyboard's expansion may be automatically sensed and power to the keyboard may be automatically supplied at this point. Each row of scissors linkages is typically coupled in a similar fashion to the inside of housings 1 and 2.

Detailed Description Text (10):

When not in operation, keyboard assembly 10 may be placed in its collapsed position (FIGS. 2 and 5) by pushing protective housing sides 1 and 2 together until the sides cover keys 3. A latch may determine the end point and the side portions may lock, for example, via a keylock switch, to provide a measure of security. To provide the most compact folded size while allowing one-step expanding and collapsing, in one embodiment, keys 3 are pivotally linked to each other by a row of scissors-like X-shaped linkages 4. FIGS. 3-5 show the collapsible and expandable nature of linkages 4.

Detailed Description Text (11):

FIG. 6 shows a magnified view of three keys 3 of keyboard assembly 10 coupled to a row of scissors or X-shaped units or linkages 4. As shown in FIG. 6, each scissors linkage is composed of two legs pivotally joined at hub 5, for example, by flanged pins or

rivets 30. Each scissors or X-shaped linkage is pivotally joined to a horizontally adjacent scissors linkage at lower and upper hubs 6 and 7, respectively.

Detailed Description Text (12):

As shown in FIG. 6, three scissors linkages 4a, 4b, and 4c are interconnected in series along a row. Three keys are supported by this row. Each key 3 is supported by and coupled to two adjoining scissors linkages. Scissors linkage 4a is comprised of legs 4d and 4e which are pivotally coupled at hub 5 (which is also referred to as a scissors pivot point) formed by overlapping openings in legs 4d and 4e. The scissors linkage 4a also includes an arm 8 which is rotationally coupled to hub 6 (which is also referred to as a coupling pivot point) at one end of arm 8 and is rotationally coupled to hub 9 on the key base 11b of the left-most key of FIG. 6. Hub 6 is formed by overlapping openings in arm 8, leg 4e and leg 4f. Hub 9 is formed by overlapping openings in arm 8 and key base 11b. Each of these hubs is secured by a pin in one embodiment. Leg 4d of scissors linkage 4a is rotationally coupled to leg 4g at coupling pivot point 7; coupling pivot point 7 is also rotationally coupled to the key base 11b of this left-most key. Coupling pivot point 7 is formed by overlapping openings in leg 4d, leg 4g and key base 11. Coupling pivot point 7 is secured by a pin in one embodiment of the invention. Leg 4e of scissors linkage 4a is rotationally coupled to leg 4f at the coupling pivot point 6. Legs 4f and 4g form the scissors linkage 4b and are also rotationally coupled together by a scissors pivot point 5. Scissors linkage 4b includes an arm 8 which is rotationally coupled at coupling pivot point 6 to leg 4g and to leg 4h of scissors linkage 4c. The arm 8 of scissors linkage 4b is rotationally coupled to a key base 11b of the middle key of FIG. 6, and this key base is rotationally coupled to leg 4f of scissors linkage 4b and to leg 4i of scissors linkage 4c. The leg 4h and the leg 4i form scissors linkage 4c which is rotationally coupled to the key base 11b of the right-most key of FIG. 6. The legs 4h and 4i are pivotally coupled at the scissors pivot point 5. The key base 11b of this right-most key is coupled to an arm 8 which extends from a coupling pivot point with leg 4i and is coupled to leg 4h at a coupling pivot point on this key base 11b.

Detailed Description Text (13):

FIGS. 7-9 illustrate the pivoting of a row of linkages 4 with respect to the three keys 3 of FIG. 6. Keys 3 rotate from a horizontal position (FIG. 6) when keyboard assembly 10 is fully expanded, to approximately a 45.degree. angle when keyboard assembly 10 is partially collapsed (FIG. 7), to a nearly vertical position (FIGS. 8-9) when keyboard assembly 10 is fully collapsed. FIG. 9 is a rear view of the collapsed portion of keyboard assembly 10 of FIG. 8. Arms 8 pivotally connect linkage hubs 6 to hubs 9 of keys 3. When expanded, arms 8 and the row of scissors linkages 4 provide a strong, rigid truss, and the angles assumed by arms 8 and the row of scissors linkages 4 are such that keys are prevented from rotating even if they are pressed hard by the user.

Detailed Description Text (15):

In the embodiment described, bottom hubs 6, which pivotally join the X-linkages 4 and arms 8 at their base, are approximately horizontally equally spaced. When keyboard assembly 10 is fully collapsed, hubs 6 are in close horizontal proximity to one another. This can be seen from FIG. 5.

Detailed Description Text (16):

In one embodiment, each row of keys 3 of keyboard assembly 10 is pivotally joined to its adjacent row to provide a strong and stable structure when keyboard assembly 10 is in an expanded position. FIG. 10 shows a planar top view of a portion of keyboard assembly 10. FIG. 10 shows a portion of keys 3 from Row IV pivotally coupled to keys 3 of Row V. Three rows of scissors linkages 4 hold these seven keys. Flanged pins 29 extend through linkage hubs 7 on each row of scissors linkages and fasten to keys 3 to pivotally secure the top portion of keyboard assembly 10. Each of these pins 29 also pivotally secure at a hub 7 one leg from one scissors linkage to a leg from an adjacent scissors linkage as shown in FIG. 6. Each row of scissors linkages 4 of FIG. 10 fastens, through these pins 29, to one side of each key along a row of keys through the corresponding hub 7. The other side of each key along this row is secured to an adjacent row of scissors linkages 4 through the mating of another set of pins 29 in the corresponding hubs 7 on this other side of each key. Flanged rods 31 (shown in FIG. 13) pass through bottom hubs 6 on each of the three rows of scissors linkages and spacing sleeves 32 to pivotally secure the bottom portion of keyboard assembly 10.

Each pivot point at the connection between an arm 8 and a key base 11b at a hub 9 is secured by a flanged pin 9a which extends through the opening in the arm 8 and into an opening in the key base 11b. As noted above, flanged pins or rivets 30 are used to secure each scissors pivot point 5.

Detailed Description Text (21):

In order to allow the keyboard assembly of the invention to be collapsed to a minimum length and thickness, the particular embodiment depicted in the figures utilizes various configurations of linkage shapes, arm lengths, and hub locations on the keys. Additionally, the assembly is configured so that keys rotate in different directions in different rows. FIG. 13 illustrates a perspective top view of a portion of keyboard assembly 10 of the invention. Note that there are three different key top sizes. FIG. 13 shows a portion of three rows of keys 3 (Rows III, IV, and V) and illustrates the support mechanism of such keys in part by ghost lines to indicate the construction of the mechanism beneath the keys. Keys 3 are shown in an expanded (opened) position. In FIG. 13, hubs 6 lie in vertical columns and are equally spaced in all rows. Keys 3 in Row III are pivotally supported by the configuration of a series of X-linkages 4, arms 8, and key hub locations shown in detail in FIGS. 14 and 15. As Row III collapses, keys 3 rotate in a clockwise direction. The keys in Row IV are pivotally supported by the configuration shown in FIGS. 6-9. As Row IV collapses, keys 3 in row IV rotate in a counter-clockwise direction. This allows, in one embodiment, a full-sized laptop keyboard (about 11 inches long excluding its frame) to fold to 3.25 inches in length, including its housing.

Detailed Description Text (22):

Row III contains the wide "Enter" key 37 which spans two bottom hubs 6. FIGS. 14-16 illustrate a planar front view of the rotation of the keys of Row III shown in FIG. 13. To allow the keyboard assembly to fold to a minimum length and thickness, linkage 13b, located between Rows III and IV, pivotally supports the front side of the ".vertline..backslash." key in Row IV at hub 14b, and has an angled extension 15 to pivotally support the back side of the "Pg Dn" key in Row III at hub 16. Similarly, linkage 17, located between Row IV and Row V, pivotally supports the back side of the ".vertline..backslash." key at hub 18, and has an angled extension 19, to pivotally support the front side of the "Home" key in Row V at hub 20. Linkage 13 shown in FIG. 13 includes a hub 14a which couples the linkage 13 to an adjacent leg on the scissors linkage to the right of the "Enter" key. The extension 15 of linkage 13 pivotally supports the front of the "Pg Dn" key at hub 16. This is also shown in FIG. 15. The hub 7a is not coupled to the "Pg Dn" key but is coupled to the adjacent scissors linkage to the right of the "Pg Dn" key.

Detailed Description Text (24):

In addition to accommodating keys of different widths, the linkage design of the invention allows keys on one row to be horizontally displaced with respect to keys on an adjacent row (e.g. staggered key columns), thereby conforming to standard keyboard layouts, such as for example a "QWERTY" layout even though the rows are pivotally joined to each other. For example, keys 3 in Row IV are pivotally supported on the front side by hubs 7 of linkages 4 (FIGS. 6, 10, and 13). However, linkages 33 located between Row IV and Row V have angled extensions 21. This is illustrated in FIG. 13 and in a front view portion of Row V shown in FIG. 17 in an expanded position and FIGS. 18-19 in a collapsed position. As shown in FIGS. 13 and 17-19, there are two hubs 34 and 35 on extensions 21, which lie on a horizontal axis when the keyboard is expanded (FIGS. 13 and 17). In FIG. 13, linkage 33 pivotally supports the "{[" key of Row IV at hub 34. The same linkage 33 pivotally supports the "+=" key 3 of Row V at adjacent hub 35. In this manner, the keys in Row V are displaced horizontally with respect to the keys in Row IV. When fully collapsed, extensions 21 "nest" allowing the linkages to be compressed to their most compact position. This is illustrated in front and rear views by FIGS. 18 and 19, respectively.

Detailed Description Text (27):

The left and right-most linkages of the embodiment of the keyboard assembly of the invention are pivotally joined to the housing side portions 1 and 2, respectively, by bottom pivot pins 23 at bottom hubs 6 and slidably joined to the housing side portions 1 and 2, respectively, by top pins 24, which slide in slots 25 of housing side portions 1 and 2, respectively (see FIGS. 3, 4, and 5). Two sets of scissors or X-shaped linkages (without associated keys), located on the left- and right-most sides